

# Reference Tables for Physical Setting/EARTH SCIENCE

## Radioactive Decay Data

RADIOACTIVE ISOTOPE	DISINTEGRATION	HALF-LIFE (years)
Carbon-14	$^{14}\text{C} \rightarrow ^{14}\text{N}$	$5.7 \times 10^3$
Potassium-40	$^{40}\text{K} \xrightarrow{\text{radioactive decay}} ^{40}\text{Ar} \xrightarrow{\text{radioactive decay}} ^{40}\text{Ca}$	$1.3 \times 10^9$
Uranium-238	$^{238}\text{U} \rightarrow ^{206}\text{Pb}$	$4.5 \times 10^9$
Rubidium-87	$^{87}\text{Rb} \rightarrow ^{87}\text{Sr}$	$4.9 \times 10^{10}$

## Equations

$$\text{Eccentricity} = \frac{\text{distance between foci}}{\text{length of major axis}}$$

$$\text{Gradient} = \frac{\text{change in field value}}{\text{distance}}$$

$$\text{Rate of change} = \frac{\text{change in value}}{\text{time}}$$

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

## Specific Heats of Common Materials

MATERIAL	SPECIFIC HEAT (Joules/gram • °C)
Liquid water	4.18
Solid water (ice)	2.11
Water vapor	2.00
Dry air	1.01
Basalt	0.84
Granite	0.79
Iron	0.45
Copper	0.38
Lead	0.13

## Properties of Water

Heat energy gained during melting . . . . .	334 J/g
Heat energy released during freezing . . . . .	334 J/g
Heat energy gained during vaporization . . . . .	2260 J/g
Heat energy released during condensation . . . . .	2260 J/g
Density at 3.98°C . . . . .	1.0 g/mL

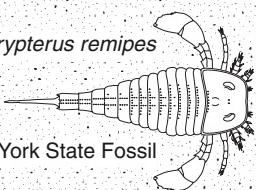
## Average Chemical Composition of Earth's Crust, Hydrosphere, and Troposphere

ELEMENT (symbol)	CRUST		HYDROSPHERE	TROPOSPHERE
	Percent by mass	Percent by volume		
Oxygen (O)	46.10	94.04	33.0	21.0
Silicon (Si)	28.20	0.88		
Aluminum (Al)	8.23	0.48		
Iron (Fe)	5.63	0.49		
Calcium (Ca)	4.15	1.18		
Sodium (Na)	2.36	1.11		
Magnesium (Mg)	2.33	0.33		
Potassium (K)	2.09	1.42		
Nitrogen (N)				78.0
Hydrogen (H)			66.0	
Other	0.91	0.07	1.0	1.0

## 2011 EDITION

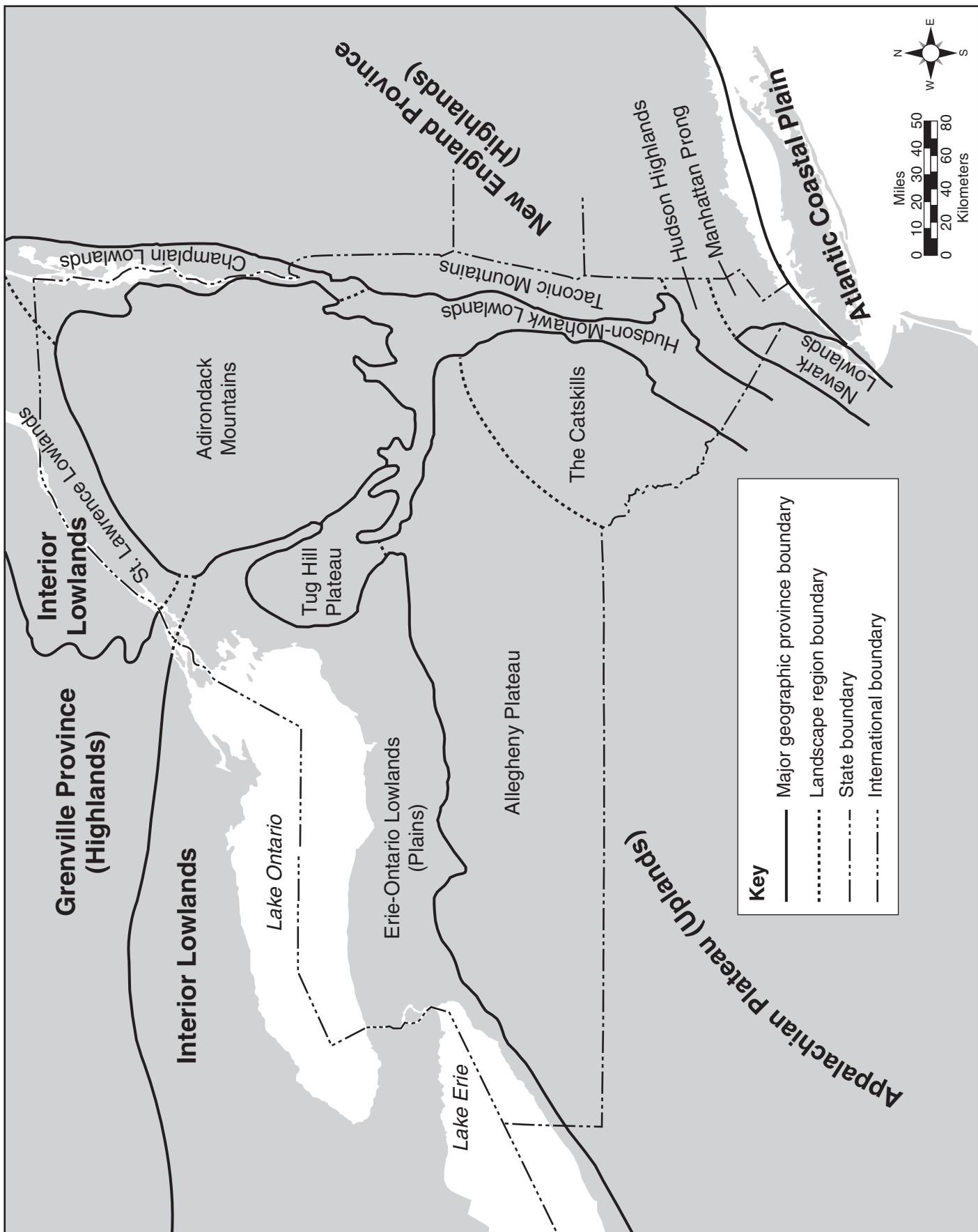
This edition of the Earth Science Reference Tables should be used in the classroom beginning in the 2011–12 school year. The first examination for which these tables will be used is the January 2012 Regents Examination in Physical Setting /Earth Science.

*Eurypterus remipes*



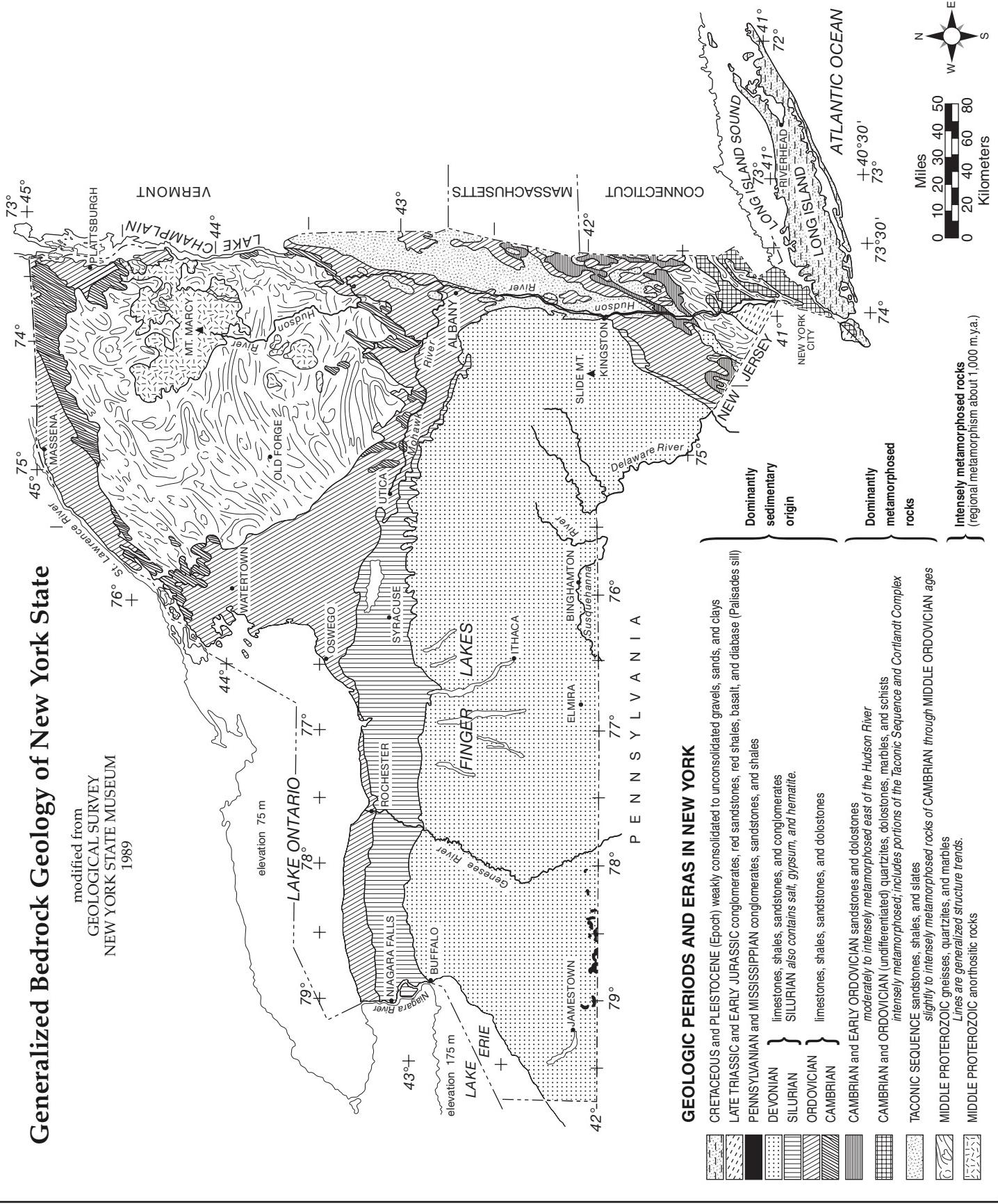
New York State Fossil

## Generalized Landscape Regions of New York State

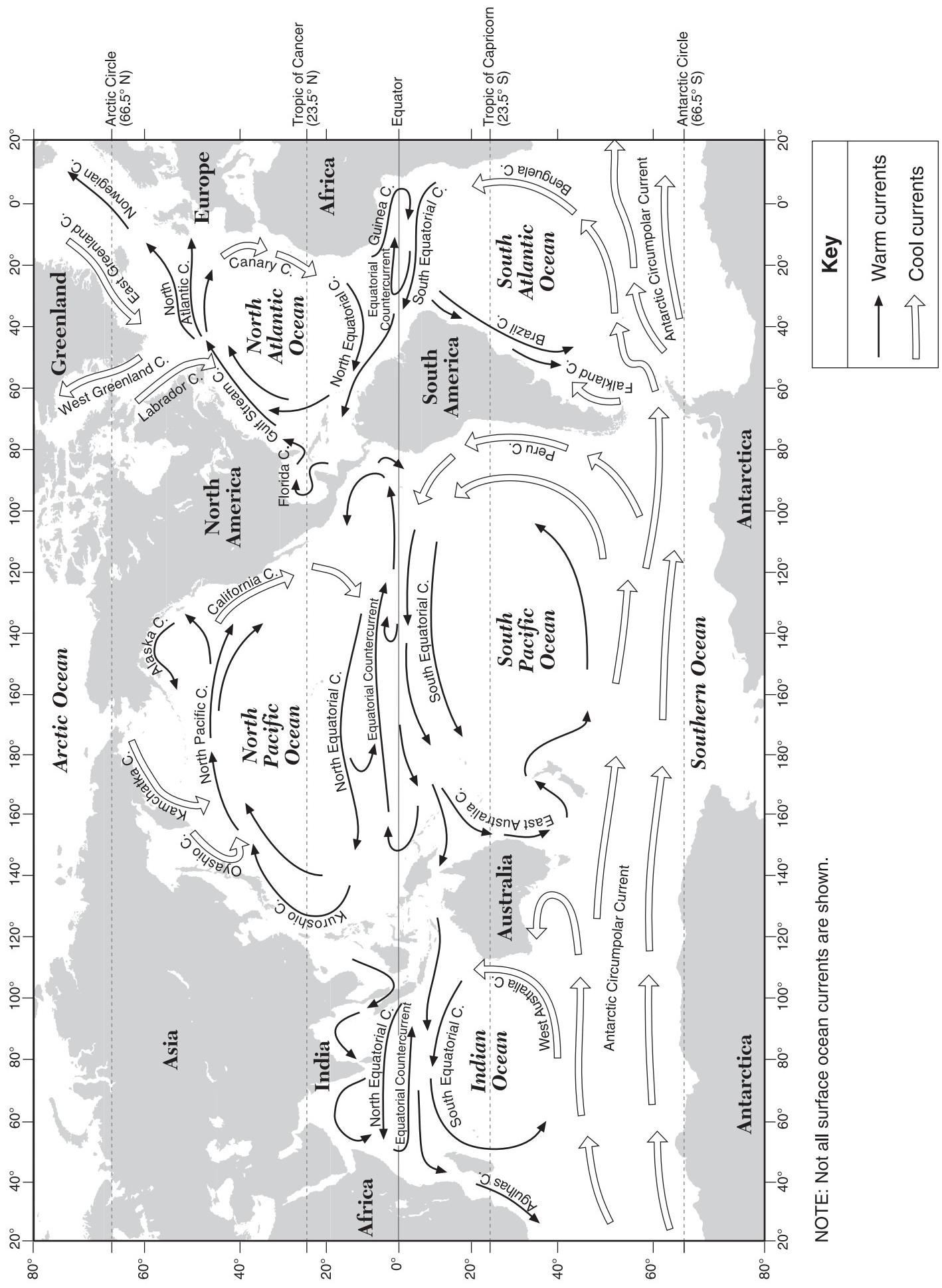


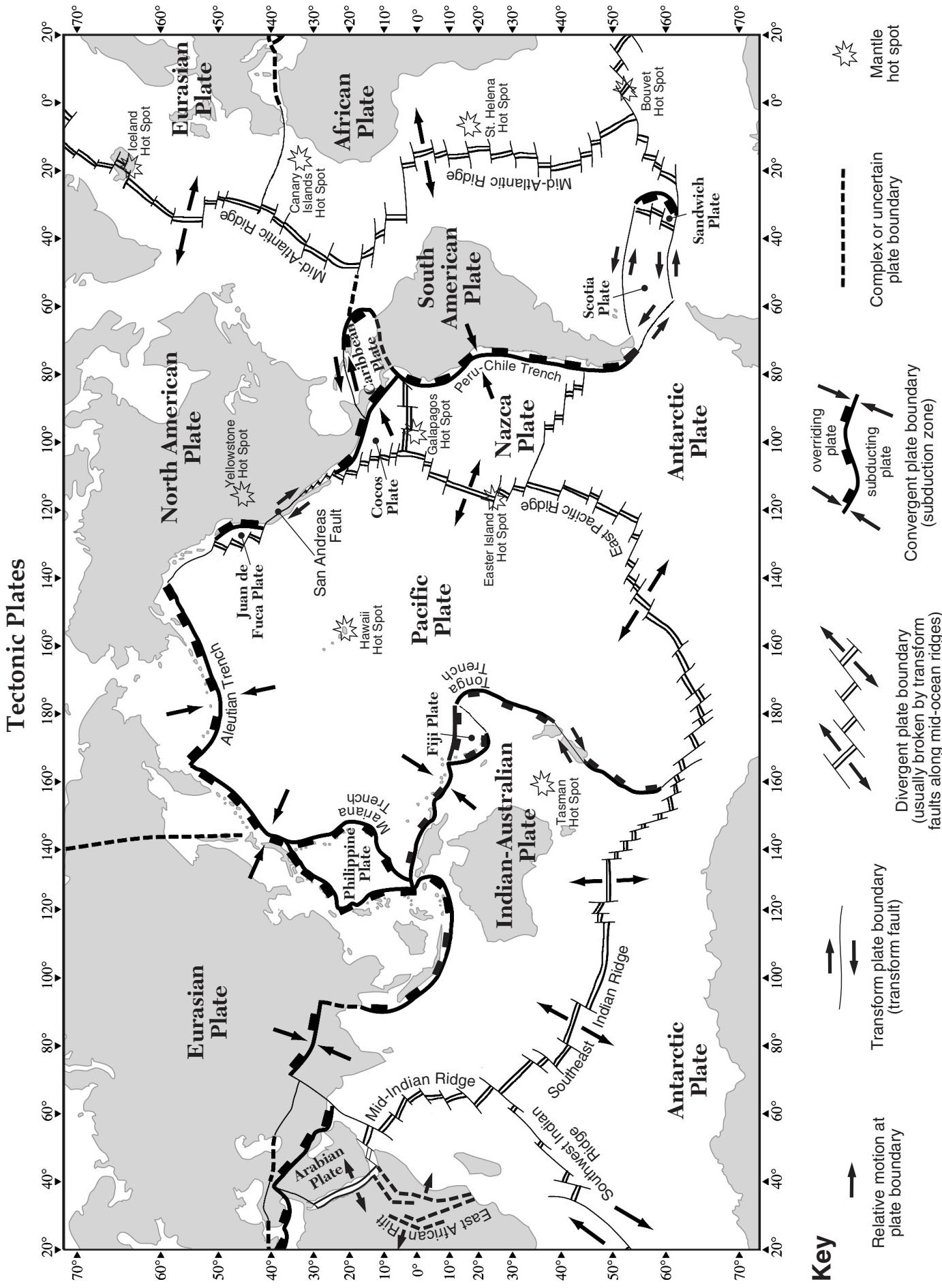
## Generalized Bedrock Geology of New York State

modified from  
GEOLOGICAL SURVEY  
NEW YORK STATE MUSEUM  
1989



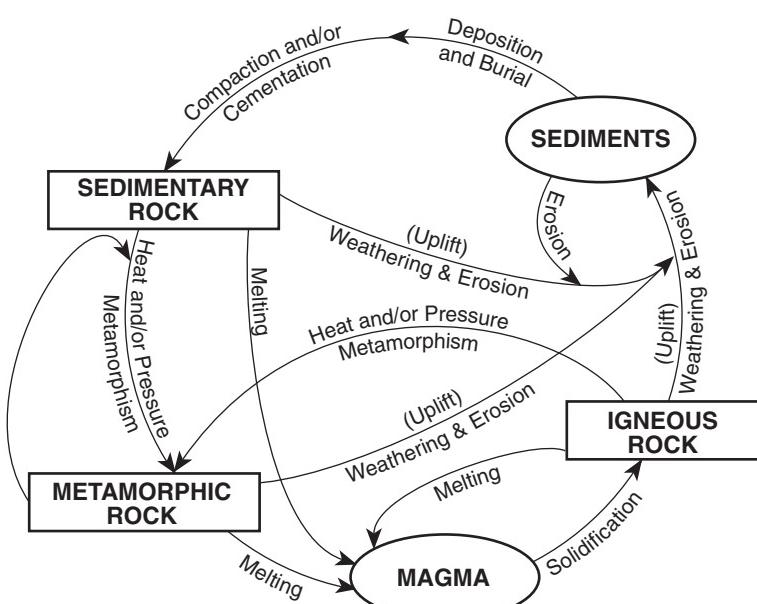
## Surface Ocean Currents



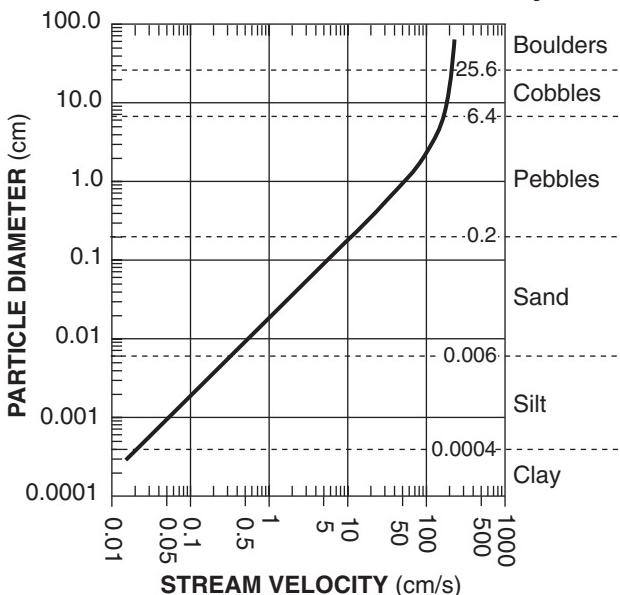


**NOTE:** Not all mantle hot spots, plates, and boundaries are shown.

## Rock Cycle in Earth's Crust



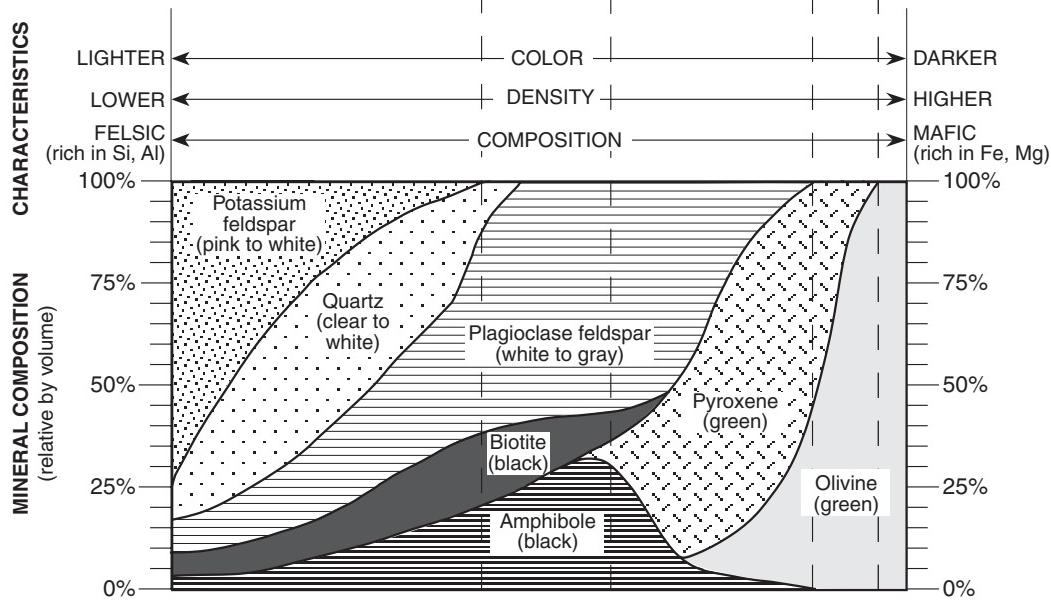
## Relationship of Transported Particle Size to Water Velocity



This generalized graph shows the water velocity needed to maintain, but not start, movement. Variations occur due to differences in particle density and shape.

## Scheme for Igneous Rock Identification

ENVIRONMENT OF FORMATION IGNEOUS ROCKS	Obsidian (usually appears black)		Basaltic glass		CRYSTAL SIZE	TEXTURE	
	EXTRUSIVE (Volcanic)					Glassy	Non-vesicular
INTRUSIVE (Plutonic)	Pumice		Scoria			Vesicular (gas pockets)	
	Vesicular rhyolite	Vesicular andesite	Vesicular basalt				
	Rhyolite	Andesite	Basalt			Fine	
			Diabase				
	Granite	Diorite	Gabbro		Peridotite	Coarse	
	Pegmatite				Dunite	Very coarse	Non-vesicular
					10 mm or larger		
					1 mm to 10 mm		
					less than 1 mm		



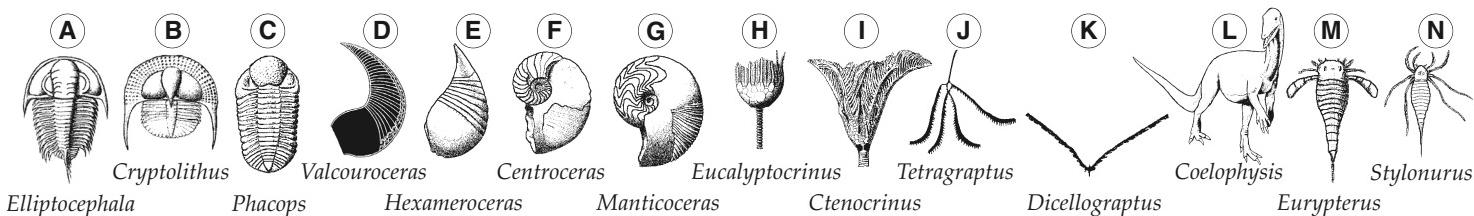
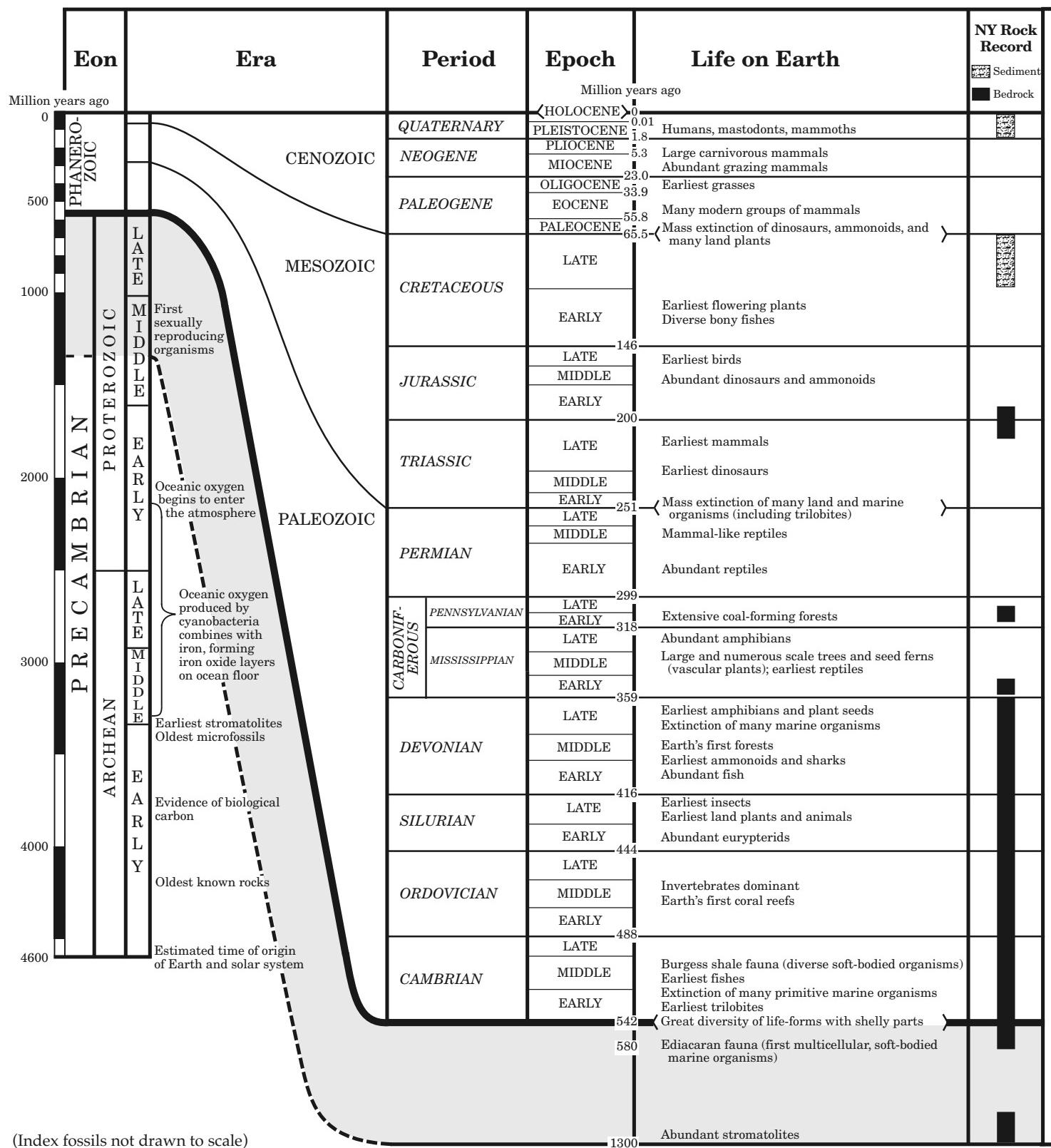
## Scheme for Sedimentary Rock Identification

<b>INORGANIC LAND-DERIVED SEDIMENTARY ROCKS</b>					
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	Conglomerate	
	Sand (0.006 to 0.2 cm)		Angular fragments	Breccia	
	Silt (0.0004 to 0.006 cm)		Fine to coarse	Sandstone	
	Clay (less than 0.0004 cm)		Very fine grain	Siltstone	
			Compact; may split easily	Shale	
<b>CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS</b>					
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	Rock salt	
		Gypsum		Rock gypsum	
		Dolomite		Dolostone	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	Limestone	
Bioclastic		Carbon		Bituminous coal	

## Scheme for Metamorphic Rock Identification

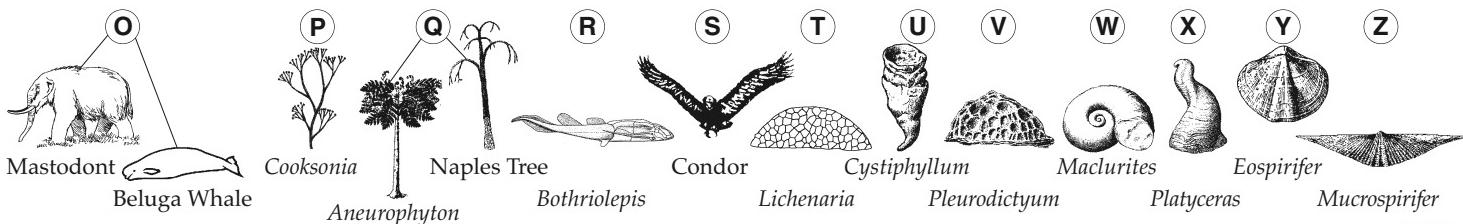
TEXTURE		GRAIN SIZE	COMPOSITION	TYPE OF METAMORPHISM	COMMENTS	ROCK NAME	MAP SYMBOL
FOLIATED MINERAL ALIGNMENT	Fine	MICA	Regional (Heat and pressure increases)	Low-grade metamorphism of shale	Slate		
		QUARTZ			Phyllite		
		FELDSPAR			Schist		
	Medium to coarse	AMPHIBOLE			Gneiss		
NONFOLIATED BANDING	Fine	GARNET					
	Fine	PYROXENE					
	Medium to coarse						
	Fine	Carbon	Regional	Metamorphism of bituminous coal	Anthracite coal		
	Fine	Various minerals	Contact (heat)	Various rocks changed by heat from nearby magma/lava	Hornfels		
	Fine to coarse	Quartz	Regional or contact	Metamorphism of quartz sandstone	Quartzite		
	Coarse	Calcite and/or dolomite		Metamorphism of limestone or dolostone	Marble		
	Coarse	Various minerals		Pebbles may be distorted or stretched	Metaconglomerate		

# GEOLOGIC HISTORY

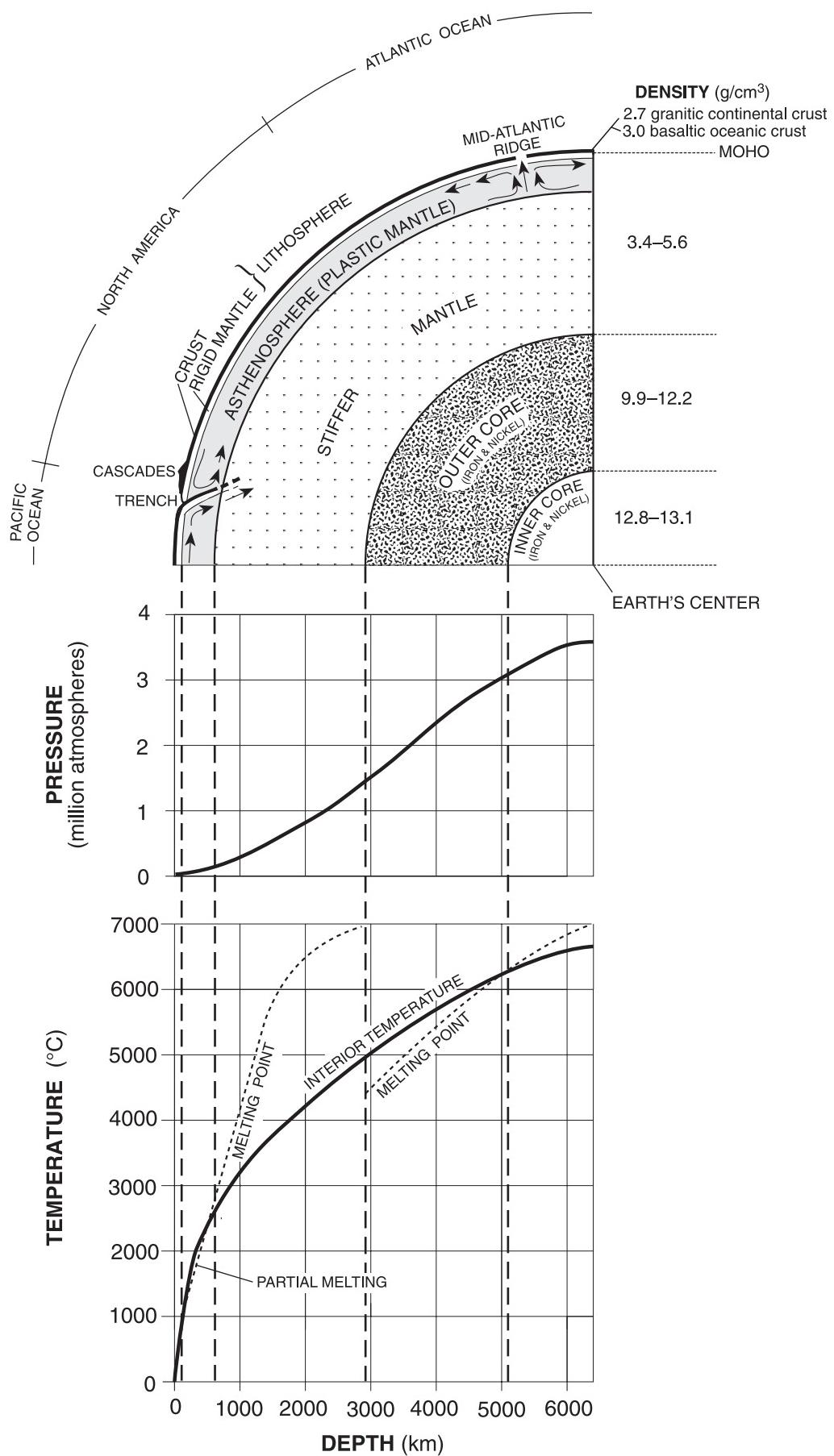


# OF NEW YORK STATE

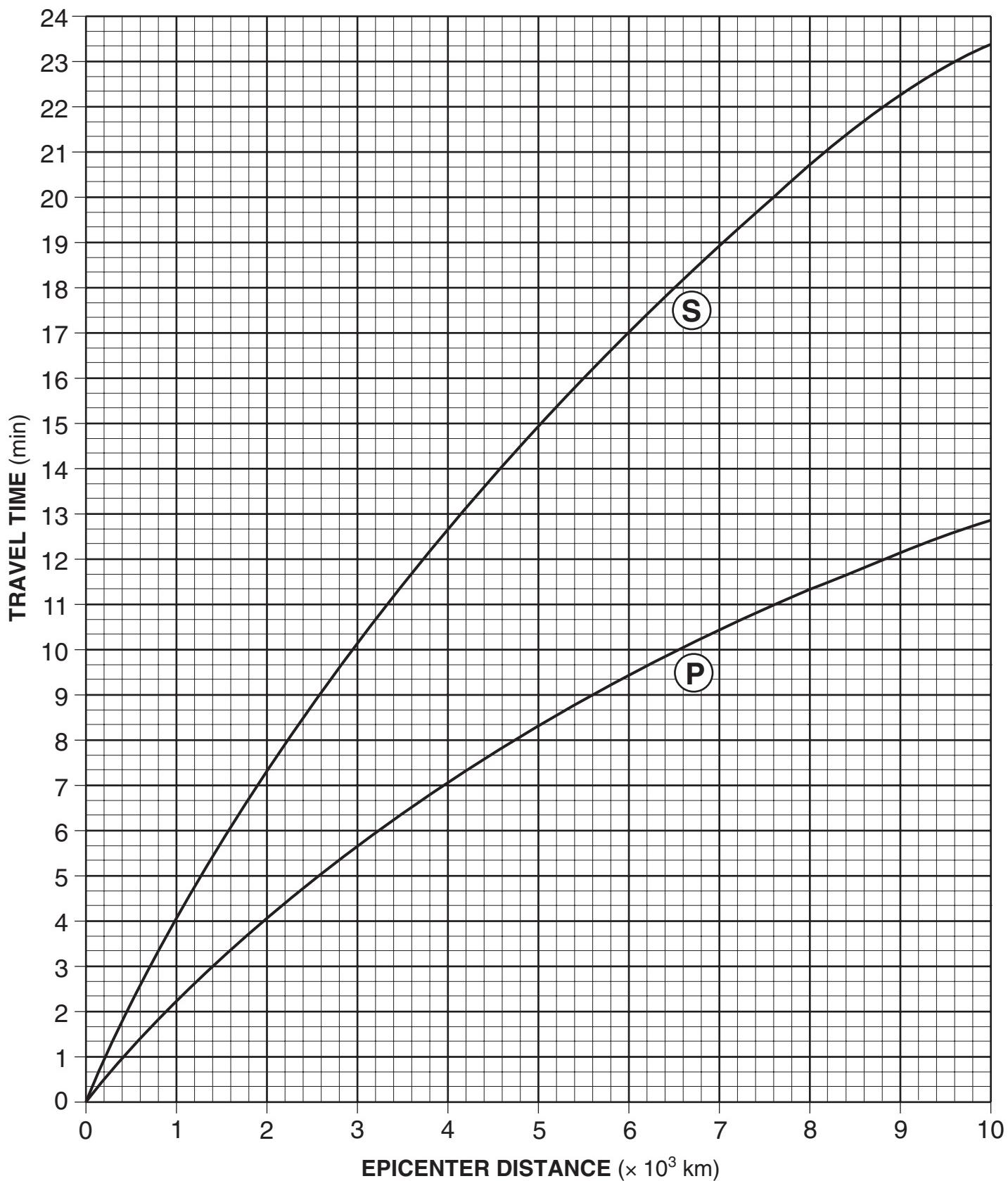
Time Distribution of Fossils (including important fossils of New York)	Important Geologic Events in New York	Inferred Positions of Earth's Landmasses
<p>The center of each lettered circle indicates the approximate time of existence of a specific index fossil (e.g. Fossil A lived at the end of the Early Cambrian).</p>	<p>Advance and retreat of last continental ice</p>	<p>59 million years ago</p>
<p>NAUTILOIDS AMMONOIDS CRINOIDS TRILOBITES C</p> <p>O DINOSAURS MAMMALS EURYPTERIDS G</p> <p>S BIRDS VASCULAR PLANTS GRAPTOLITES H</p> <p>L CORALS GASTROPODS PLACODERM FISH N R</p> <p>BIRDS M P X Z V U Y T W</p> <p>NAUTILOIDS AMMONOIDS CRINOIDS TRILOBITES C</p> <p>O DINOSAURS MAMMALS EURYPTERIDS G</p> <p>S BIRDS VASCULAR PLANTS GRAPTOLITES H</p> <p>L CORALS GASTROPODS PLACODERM FISH N R</p> <p>BIRDS M P X Z V U Y T W</p>	<p>Sands and clays underlying Long Island and Staten Island deposited on margin of Atlantic Ocean</p> <p>Dome-like uplift of Adirondack region begins</p>	<p>119 million years ago</p>
<p>Eurypterids Graptolites Placoderm Fish Bothriolepis Aneurophyton Lichenaria Cystiphyllum Pleurodictyum Maclurites Platycteras Eospirifer Mucrospirifer</p>	<p>Initial opening of Atlantic Ocean North America and Africa separate Intrusion of Palisades sill Pangaea begins to break up</p>	<p>232 million years ago</p>
<p>Trilobites Ammonoids Crinoids Nautiloids M</p> <p>C F G I H J K L O S T U V W X Y Z</p>	<p>Alleghenian orogeny caused by collision of North America and Africa along transform margin, forming Pangaea</p>	<p>359 million years ago</p>
<p>Trilobites Ammonoids Crinoids Nautiloids M</p> <p>C F G I H J K L O S T U V W X Y Z</p>	<p>Catskill delta forms Erosion of Acadian Mountains Acadian orogeny caused by collision of North America and Avalon and closing of remaining part of Iapetus Ocean</p>	<p>458 million years ago</p>
<p>Trilobites Ammonoids Crinoids Nautiloids M</p> <p>C F G I H J K L O S T U V W X Y Z</p>	<p>Salt and gypsum deposited in evaporite basins</p>	
<p>Trilobites Ammonoids Crinoids Nautiloids M</p> <p>C F G I H J K L O S T U V W X Y Z</p>	<p>Erosion of Taconic Mountains; Queenston delta forms Taconian orogeny caused by closing of western part of Iapetus Ocean and collision between North America and volcanic island arc</p>	
<p>Trilobites Ammonoids Crinoids Nautiloids M</p> <p>C F G I H J K L O S T U V W X Y Z</p>	<p>Widespread deposition over most of New York along edge of Iapetus Ocean</p>	
	<p>Rifting and initial opening of Iapetus Ocean Erosion of Grenville Mountains Grenville orogeny: metamorphism of bedrock now exposed in the Adirondacks and Hudson Highlands</p>	



## Inferred Properties of Earth's Interior



### Earthquake P-Wave and S-Wave Travel Time



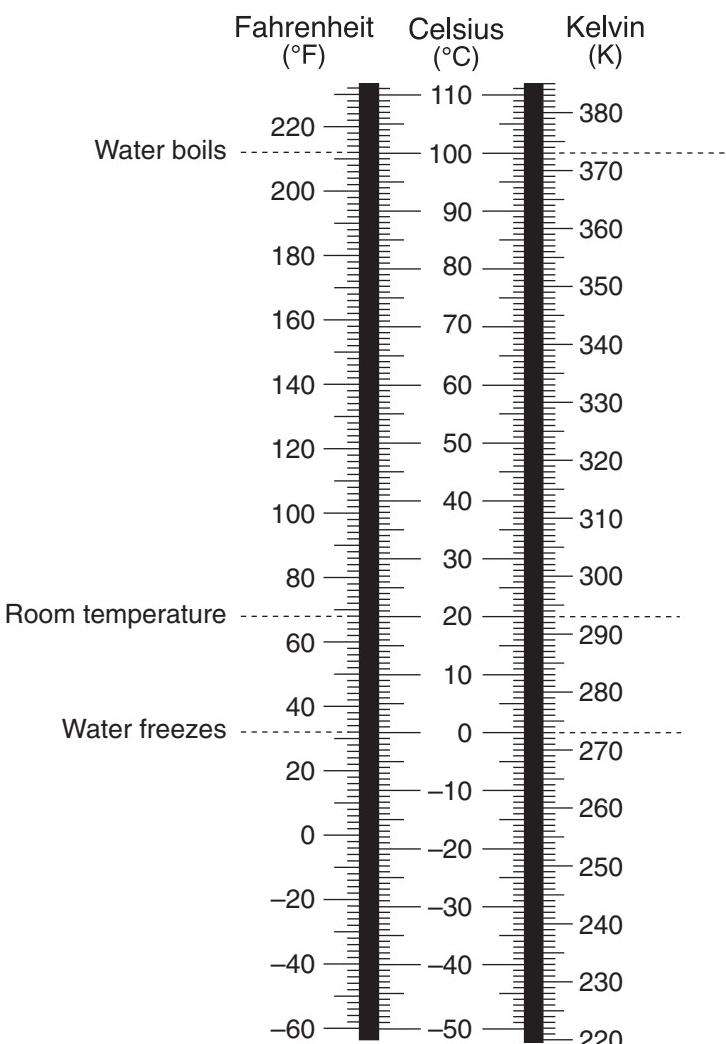
## Dewpoint (°C)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
-20	-20	-33													
-18	-18	-28													
-16	-16	-24													
-14	-14	-21	-36												
-12	-12	-18	-28												
-10	-10	-14	-22												
-8	-8	-12	-18	-29											
-6	-6	-10	-14	-22											
-4	-4	-7	-12	-17	-29										
-2	-2	-5	-8	-13	-20										
0	0	-3	-6	-9	-15	-24									
2	2	-1	-3	-6	-11	-17									
4	4	1	-1	-4	-7	-11	-19								
6	6	4	1	-1	-4	-7	-13	-21							
8	8	6	3	1	-2	-5	-9	-14							
10	10	8	6	4	1	-2	-5	-9	-14	-28					
12	12	10	8	6	4	1	-2	-5	-9	-16					
14	14	12	11	9	6	4	1	-2	-5	-10	-17				
16	16	14	13	11	9	7	4	1	-1	-6	-10	-17			
18	18	16	15	13	11	9	7	4	2	-2	-5	-10	-19		
20	20	19	17	15	14	12	10	7	4	2	-2	-5	-10	-19	
22	22	21	19	17	16	14	12	10	8	5	3	-1	-5	-10	-19
24	24	23	21	20	18	16	14	12	10	8	6	2	-1	-5	-10
26	26	25	23	22	20	18	17	15	13	11	9	6	3	0	-4
28	28	27	25	24	22	21	19	17	16	14	11	9	7	4	1
30	30	29	27	26	24	23	21	19	18	16	14	12	10	8	5

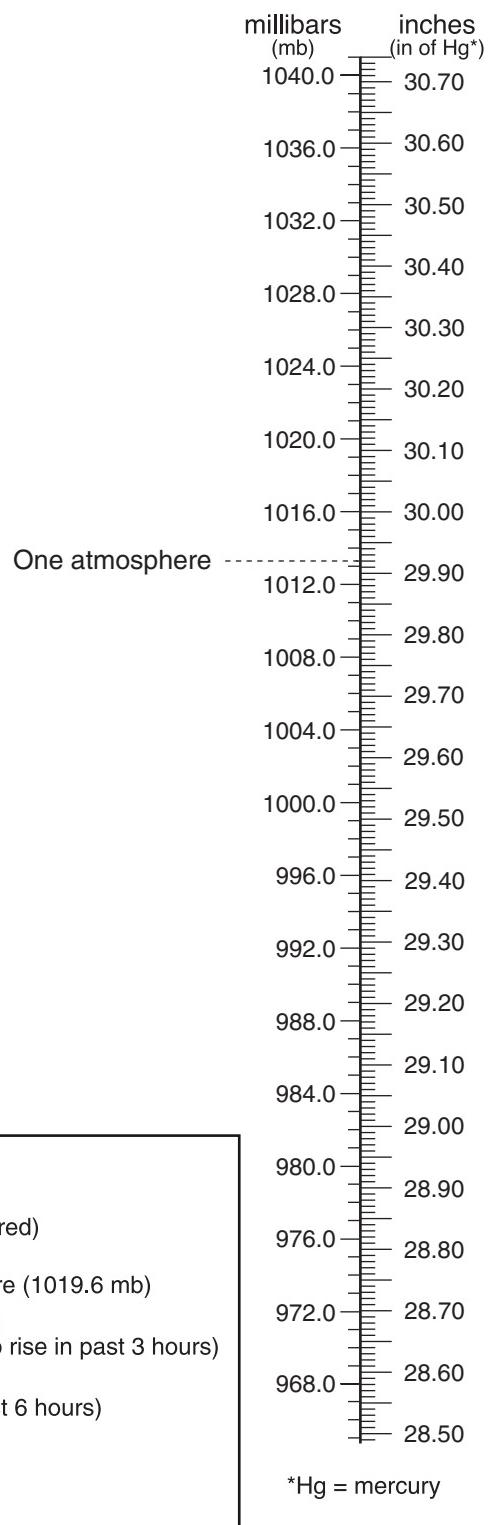
## Relative Humidity (%)

Dry-Bulb Temperature (°C)	Difference Between Wet-Bulb and Dry-Bulb Temperatures (C°)														
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
-20	100	28													
-18	100	40													
-16	100	48													
-14	100	55	11												
-12	100	61	23												
-10	100	66	33												
-8	100	71	41	13											
-6	100	73	48	20											
-4	100	77	54	32	11										
-2	100	79	58	37	20	1									
0	100	81	63	45	28	11									
2	100	83	67	51	36	20	6								
4	100	85	70	56	42	27	14								
6	100	86	72	59	46	35	22	10							
8	100	87	74	62	51	39	28	17	6						
10	100	88	76	65	54	43	33	24	13	4					
12	100	88	78	67	57	48	38	28	19	10	2				
14	100	89	79	69	60	50	41	33	25	16	8	1			
16	100	90	80	71	62	54	45	37	29	21	14	7	1		
18	100	91	81	72	64	56	48	40	33	26	19	12	6		
20	100	91	82	74	66	58	51	44	36	30	23	17	11	5	
22	100	92	83	75	68	60	53	46	40	33	27	21	15	10	4
24	100	92	84	76	69	62	55	49	42	36	30	25	20	14	9
26	100	92	85	77	70	64	57	51	45	39	34	28	23	18	13
28	100	93	86	78	71	65	59	53	47	42	36	31	26	21	17
30	100	93	86	79	72	66	61	55	49	44	39	34	29	25	20

## Temperature



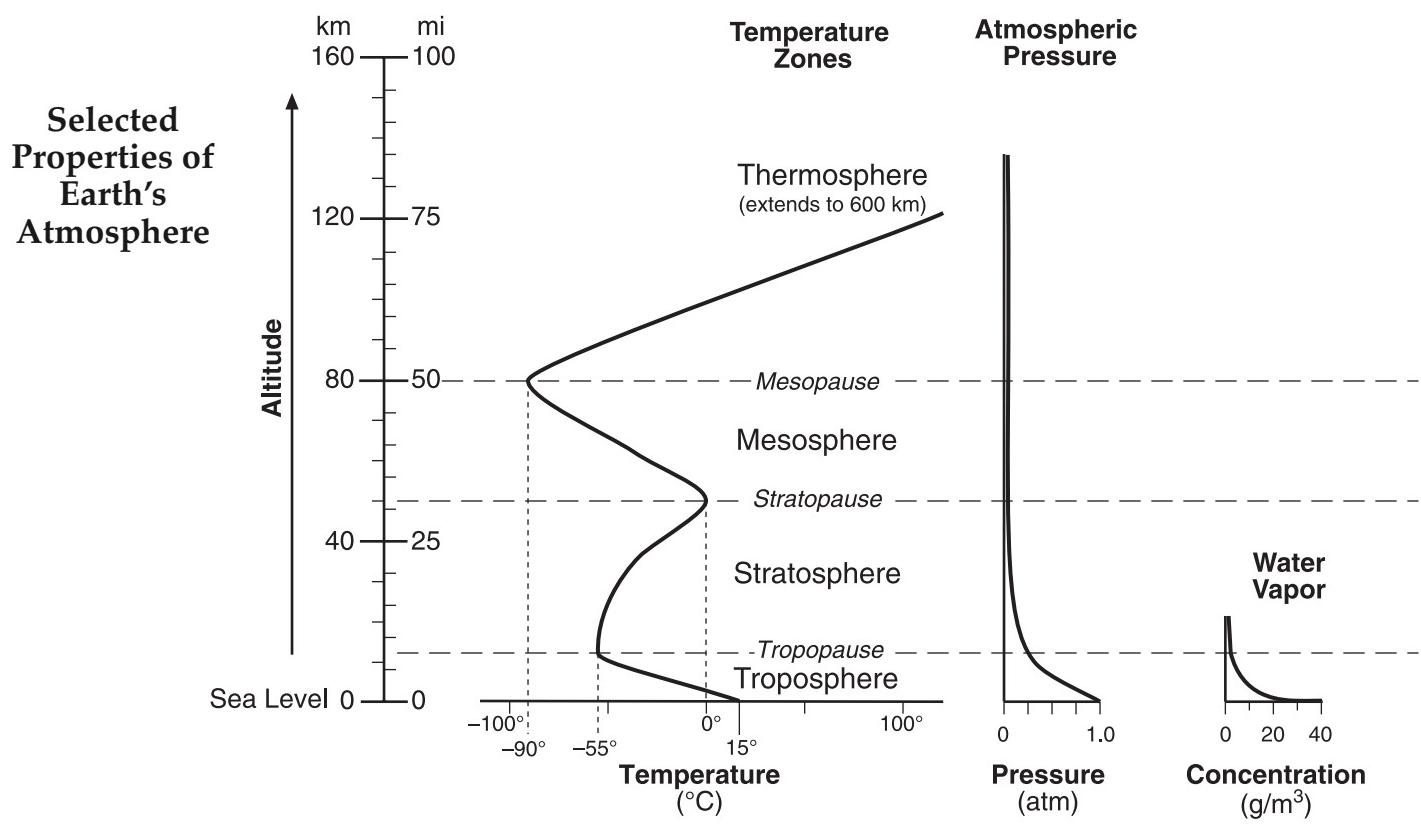
## Pressure



## Key to Weather Map Symbols

Station Model	Station Model Explanation
	<p>Present weather Amount of cloud cover (approximately 75% covered)</p> <p>Temperature (°F) 28</p> <p>Visibility (mi) <math>\frac{1}{2}*</math></p> <p>Dewpoint (°F) 27</p> <p>Wind speed Wind direction (from the southwest)</p> <p>[whole feather = 10 knots half feather = 5 knots total = 15 knots]</p> <p>(1 knot = 1.15 mi/h)</p> <p>196 Barometric pressure (1019.6 mb)</p> <p>+19/ Barometric trend (a steady 1.9-mb rise in past 3 hours)</p> <p>.25 Precipitation (0.25 inches in past 6 hours)</p>

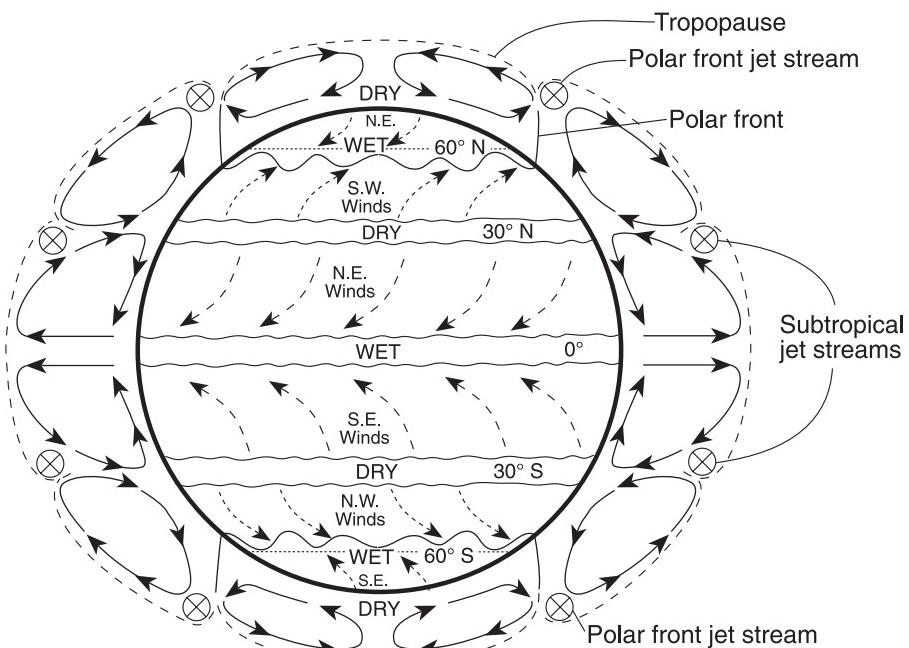
Present Weather	Air Masses	Fronts	Hurricane
	<p>cA continental arctic cP continental polar cT continental tropical mT maritime tropical mP maritime polar</p>	<p>Cold</p> <p>Warm</p> <p>Stationary</p> <p>Occluded</p>	<p>Tornado</p>



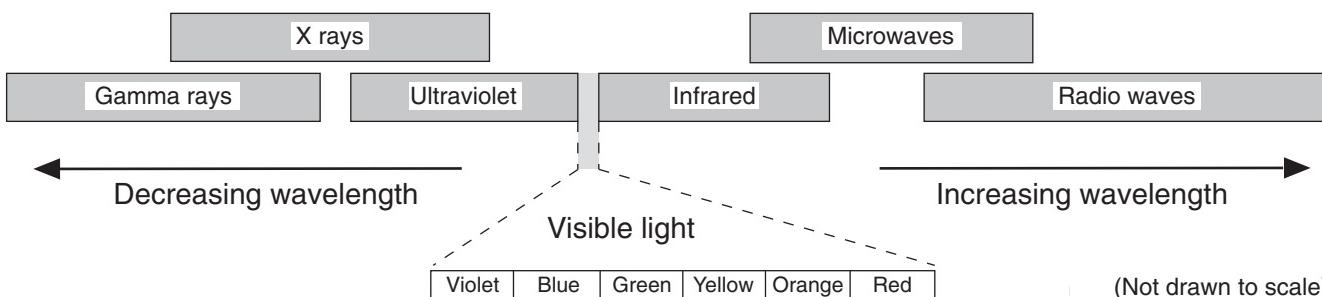
### Planetary Wind and Moisture Belts in the Troposphere

The drawing on the right shows the locations of the belts near the time of an equinox. The locations shift somewhat with the changing latitude of the Sun's vertical ray. In the Northern Hemisphere, the belts shift northward in the summer and southward in the winter.

(Not drawn to scale)

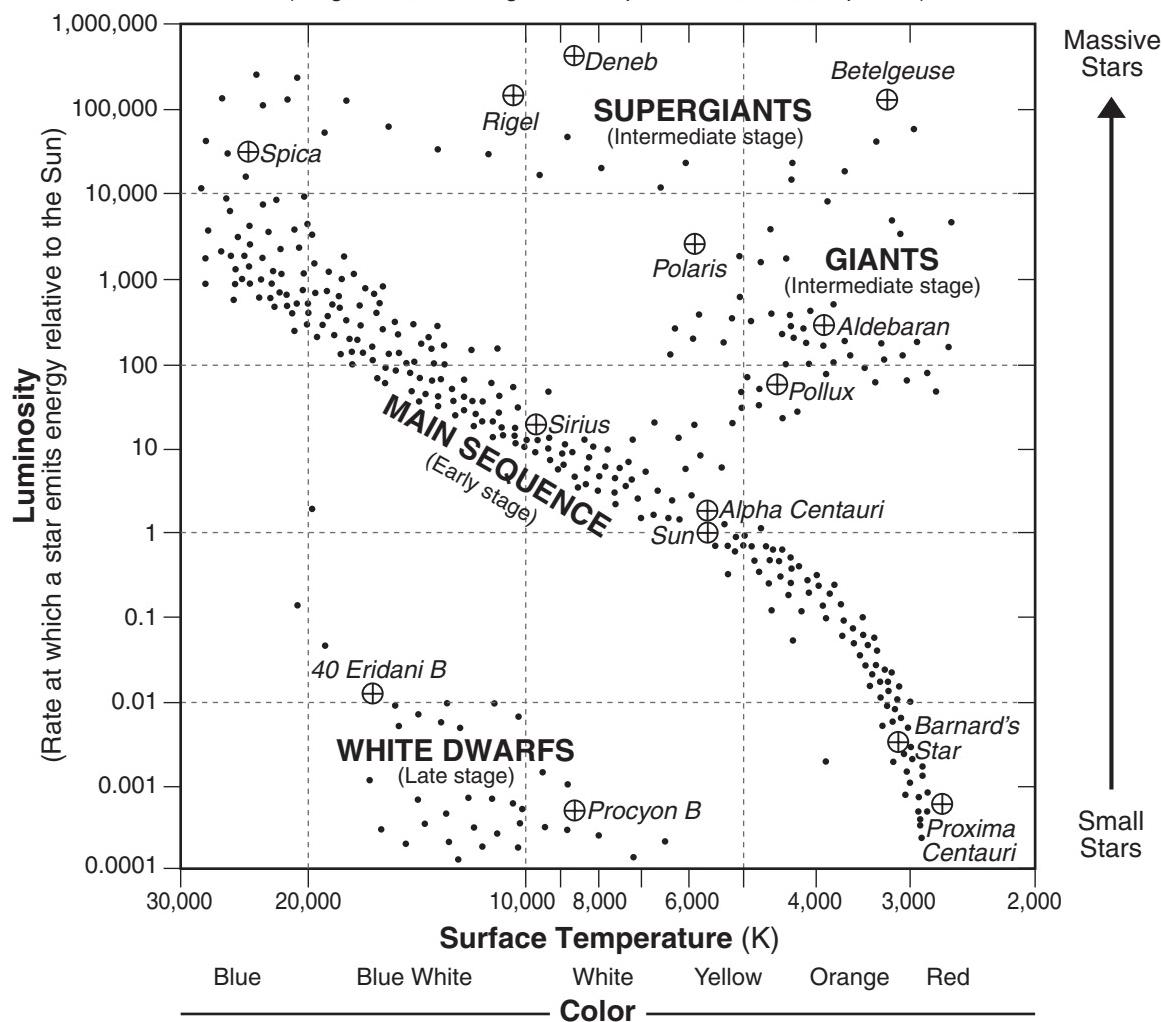


### Electromagnetic Spectrum



## Characteristics of Stars

(Name in italics refers to star represented by a  $\oplus$ .)  
(Stages indicate the general sequence of star development.)



## Solar System Data

Celestial Object	Mean Distance from Sun (million km)	Period of Revolution (d=days) (y=years)	Period of Rotation at Equator	Eccentricity of Orbit	Equatorial Diameter (km)	Mass (Earth = 1)	Density (g/cm <sup>3</sup> )
SUN	—	—	27 d	—	1,392,000	333,000.00	1.4
MERCURY	57.9	88 d	59 d	0.206	4,879	0.06	5.4
VENUS	108.2	224.7 d	243 d	0.007	12,104	0.82	5.2
EARTH	149.6	365.26 d	23 h 56 min 4 s	0.017	12,756	1.00	5.5
MARS	227.9	687 d	24 h 37 min 23 s	0.093	6,794	0.11	3.9
JUPITER	778.4	11.9 y	9 h 50 min 30 s	0.048	142,984	317.83	1.3
SATURN	1,426.7	29.5 y	10 h 14 min	0.054	120,536	95.16	0.7
URANUS	2,871.0	84.0 y	17 h 14 min	0.047	51,118	14.54	1.3
NEPTUNE	4,498.3	164.8 y	16 h	0.009	49,528	17.15	1.8
EARTH'S MOON	149.6 (0.386 from Earth)	27.3 d	27.3 d	0.055	3,476	0.01	3.3

## Properties of Common Minerals

LUSTER	HARDNESS	CLEAVAGE	FRACTURE	COMMON COLORS	DISTINGUISHING CHARACTERISTICS	USE(S)	COMPOSITION*	MINERAL NAME
Metallic luster	1–2	✓		silver to gray	black streak, greasy feel	pencil lead, lubricants	C	Graphite
	2.5	✓		metallic silver	gray-black streak, cubic cleavage, density = 7.6 g/cm <sup>3</sup>	ore of lead, batteries	PbS	Galena
	5.5–6.5		✓	black to silver	black streak, magnetic	ore of iron, steel	Fe <sub>3</sub> O <sub>4</sub>	Magnetite
	6.5		✓	brassy yellow	green-black streak, (fool's gold)	ore of sulfur	FeS <sub>2</sub>	Pyrite
Either	5.5–6.5 or 1		✓	metallic silver or earthy red	red-brown streak	ore of iron, jewelry	Fe <sub>2</sub> O <sub>3</sub>	Hematite
Nonmetallic luster	1	✓		white to green	greasy feel	ceramics, paper	Mg <sub>3</sub> Si <sub>4</sub> O <sub>10</sub> (OH) <sub>2</sub>	Talc
	2		✓	yellow to amber	white-yellow streak	sulfuric acid	S	Sulfur
	2	✓		white to pink or gray	easily scratched by fingernail	plaster of paris, drywall	CaSO <sub>4</sub> •2H <sub>2</sub> O	Selenite gypsum
	2–2.5	✓		colorless to yellow	flexible in thin sheets	paint, roofing	KAl <sub>3</sub> Si <sub>3</sub> O <sub>10</sub> (OH) <sub>2</sub>	Muscovite mica
	2.5	✓		colorless to white	cubic cleavage, salty taste	food additive, melts ice	NaCl	Halite
	2.5–3	✓		black to dark brown	flexible in thin sheets	construction materials	K(Mg,Fe) <sub>3</sub> AlSi <sub>3</sub> O <sub>10</sub> (OH) <sub>2</sub>	Biotite mica
	3	✓		colorless or variable	bubbles with acid, rhombohedral cleavage	cement, lime	CaCO <sub>3</sub>	Calcite
	3.5	✓		colorless or variable	bubbles with acid when powdered	building stones	CaMg(CO <sub>3</sub> ) <sub>2</sub>	Dolomite
	4	✓		colorless or variable	cleaves in 4 directions	hydrofluoric acid	CaF <sub>2</sub>	Fluorite
	5–6	✓		black to dark green	cleaves in 2 directions at 90°	mineral collections, jewelry	(Ca,Na)(Mg,Fe,Al)(Si,Al) <sub>2</sub> O <sub>6</sub>	Pyroxene (commonly augite)
	5.5	✓		black to dark green	cleaves at 56° and 124°	mineral collections, jewelry	CaNa(Mg,Fe) <sub>4</sub> (Al,Fe,Ti) <sub>3</sub> Si <sub>6</sub> O <sub>22</sub> (O,OH) <sub>2</sub>	Amphibole (commonly hornblende)
	6	✓		white to pink	cleaves in 2 directions at 90°	ceramics, glass	KAlSi <sub>3</sub> O <sub>8</sub>	Potassium feldspar (commonly orthoclase)
	6	✓		white to gray	cleaves in 2 directions, striations visible	ceramics, glass	(Na,Ca)AlSi <sub>3</sub> O <sub>8</sub>	Plagioclase feldspar
	6.5		✓	green to gray or brown	commonly light green and granular	furnace bricks, jewelry	(Fe,Mg) <sub>2</sub> SiO <sub>4</sub>	Olivine
	7		✓	colorless or variable	glassy luster, may form hexagonal crystals	glass, jewelry, electronics	SiO <sub>2</sub>	Quartz
	6.5–7.5		✓	dark red to green	often seen as red glassy grains in NYS metamorphic rocks	jewelry (NYS gem), abrasives	Fe <sub>3</sub> Al <sub>2</sub> Si <sub>3</sub> O <sub>12</sub>	Garnet

\*Chemical symbols:

Al = aluminum

Cl = chlorine

H = hydrogen

Na = sodium

S = sulfur

C = carbon

F = fluorine

K = potassium

O = oxygen

Si = silicon

Ca = calcium

Fe = iron

Mg = magnesium

Pb = lead

Ti = titanium

✓ = dominant form of breakage